

CRUISE REPORT¹

VESSEL: *Hi`ialakai*, Cruise 06-04 (Fig. 1)
CRUISE

PERIOD: 15 March-8 April 2006

AREA OF OPERATION: Jarvis Island, Palmyra Atoll, and Kingman Reef National Wildlife Refuges

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Division, Pacific Island Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), plus one each from the U.S. Fish and Wildlife Service (USFWS) and NOAA dive center conducted reef assessment/monitoring and mapping studies in waters surrounding the U.S. Line Islands of Jarvis Island, Palmyra Atoll, and Kingman Reef.

ITINERARY:

15 March Start of cruise. Embarked Craig Musburger (fish), Todd Wass (fish), Paula Ayotte (fish), Jim Maragos (coral, USFWS), Bernardo Vargas Angel (coral disease), Scott Godwin (invertebrates), Aline Tribollet (algae), Bonnie DeJoseph (algae), Amy Hall (towed-diver survey/fish), Edmund Coccagna (towed-diver survey /fish), Molly Timmers (towed-diver survey /habitat), Eric Dobbs (towed-diver survey /habitat), Kyle Hogrefe (oceanography), Daniel Merritt (oceanography), Charles Young (oceanography), Kevin Lino (oceanography), Scott Ferguson (mapping), Jeremy Jones (mapping), Emily Lundblad (mapping), Jonathan Weiss (mapping), Stephane Charette (divemaster) and Jim Bostick (chamber operator, NDC). Departed Pago Pago at 0930, en route for Jarvis Island. An introductory meeting was held for all scientific personnel and new crew members at 1300. During a fire drill, Third Assistant Engineer Ric Gabona was injured, losing a portion of his thumb. At 1430 the ship diverted back to Pago Pago. At 1800 the scientific party conducted a planning meeting to discuss operations at Jarvis Island. At 1845 Gabona

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was transferred ashore in a small boat, along with Executive Officer LT Matt Wingate and Medical Officer LT Mike Futch. The ship stood by outside the entrance buoy. Ric Gabona was treated and sent to Honolulu for further care. At 2230 the small boat was recovered and the vessel departed for Jarvis Island.

- 16 March Transit day. At 1000 conducted dive safety meeting. Conducted man-overboard drill. At 1800 the scientific party conducted a planning meeting to discuss operations at Palmyra Atoll. Acoustic Doppler current profiler (ADCP) data are being collected during the transits between islands.
- 17 March Transit day.
- 18 March Transit day. At 1800 the scientific party conducted a planning meeting to discuss operations at Kingman Reef.
- 19 March Transit day.
- 20 March Arrived at Jarvis Island at 0500 to begin field operations. The REA teams occupied three established sites on the north side of the island (JAR-9, JAR-8, and JAR-1). The towed-diver survey team completed six tows, circumnavigating the island. The oceanography team recovered and replaced one ocean data platform (ODP), recovered and replaced two subsurface temperature recorders (STRs) and deployed two new STRs and deployed a new sea surface temperature (SST) at the site of the one deployed in 2004 that later went adrift. The Acoustic Habitat Investigator (*AHI*) mapped 10- to 300-m depths around the island. Shipboard mapping began after all small boats were onboard, working in depths from about 400 m to 2700 m.
- 21 March Continued working at Jarvis. The rapid ecological assessment (REA) teams occupied three established sites on the south side of the island (JAR-10, JAR-4P, and JAR-2). The last site was cut short when a large manta ray cut the line to the surface float; only one transect was completed before the dive was terminated. The towed-diver survey team completed four tows and conducted one invertebrate collection dive. The oceanography team recovered and replaced two STRs and deployed two new STRs, conducted two 30-m conductivity-temperature-depth (CTD) casts and two 200-m CTD casts and performed one water quality profile at a 30-m cast site during which eight water samples were taken to be later analyzed for chlorophyll (four samples) and nutrient (four samples) content. The *AHI* completed mapping the east bank and thereafter supported the oceanography team. Shipboard mapping

was conducted during the day to cover areas close to the island which were deeper than the *AHI* can map. During the night the ship conducted two 300-m and six 500-m CTD/water quality casts during which ninety-six water samples were taken to be later analyzed for chlorophyll (48 samples) and nutrient (48 samples) content.

- 22 March Continued working at Jarvis. The REA teams established one new site (JAR-12) on the south side and occupied two established sites on the northwestern side of the island (JAR-7P and JAR-11P). The towed-diver survey team conducted two tows and conducted one dive for invertebrate collection and two dives to assist in coral assessment surveys. The oceanography team conducted 35 30-m CTD casts with 17 water quality profiles being conducted during which 142 water samples were taken to be later analyzed for nutrient (71 samples) and chlorophyll (71 samples) content. The *AHI* conducted eight 30-m and eight 200-m CTDs. The ship departed for Palmyra after all small boats were recovered.
- 23 March Transit day. Conducted collision and abandon ship drills. ADCP data are being collected during the transits between islands.
- 24 March Arrived at Palmyra Atoll at 0500 to begin field operations. The REA teams occupied three established sites on the south side of the island (PAL-25, PAL-10P and PAL-19). The towed-diver survey team completed six tows around the edge of the western bank and south of the island. The oceanography team installed a 2-MHz inverted ADCP in the channel to the west lagoon at a depth of 8 m. A string of temperature recorders was deployed nearby with recorders positioned at depths of 1, 3, and 6 m. One STR was recovered and replaced in the same location. An SST was deployed in the east lagoon along with three STRs located nearby at 5, 16 and 26 m. The STRs are attached to the SST anchor by a long line because of poor visibility at the site. Twelve 30-m CTD casts were taken with four water quality profiles conducted during which 32 water samples were taken to be later analyzed for chlorophyll (16 samples) and nutrient (16 samples) content. The *AHI* mapped the reef along the southern shore in depths between 10 and 300 m. At night the ship mapped the deeper banks around the atoll.
- 25 March Continued working at Palmyra Atoll. The REA teams occupied three established sites on the west side of the island (PAL-26, PAL-11 and PAL-5). The towed-diver survey team completed six tows in the lagoon and along the north side of the island. The oceanography team recovered an existing Coral Reef Early

Warning System (CREWS) buoy and replaced it with a refurbished unit replacing both the 540 kg anchor and recruitment plate array. In addition one STR was installed on the CREWS buoy anchor and two 8-m CTD casts were conducted near the buoy to gauge temperature and salinity drift in the buoy's sensors. The *AHI* mapped the reef along the northern shore in depths between 10 and 300 m. At night the ship mapped the deeper banks around the atoll.

26 March

Continued working at Palmyra Atoll. Bad weather delayed the start of operations until 1030. The REA teams occupied two established sites on the south side of the island (PAL-9 and PAL-1). The towed-diver survey team completed three tows around the south of the island. The oceanography team recovered two STRs and replaced them with two new ones. Ten 30-m CTD casts were conducted during which two water quality profiles were performed collecting 16 water samples for later analysis of chlorophyll (8 samples) and nutrient (8 samples) content. The *AHI* mapped the western portion of Palmyra Lagoon. At night the ship ran an 87-km ADCP box transect around the atoll. Four 500-m CTD/water quality casts were conducted during which 48 water samples were taken for later analysis of chlorophyll (24 samples) and nutrient (24 samples) content.

27 March

Continued working at Palmyra Atoll. The REA teams occupied established sites on the north side of the atoll (PAL-20, PAL-12 and PAL-21). The towed-diver survey team completed three tows around the north side of the island but ran into problems when the habitat camera housing flooded on the third tow destroying the photographic record for all tows. After the cameras were removed the housings were tested to ensure they were not leaking. Oceanography recovered and replaced one STR and deployed one new STR. Twenty-five 30-m CTD casts were conducted during which four water quality profiles were performed collecting 32 water samples for later analysis of chlorophyll (16 samples) and nutrient (16 samples) content. The *AHI* mapped the middle lagoon and started mapping the western bank. At night the ship mapped the deeper banks around the atoll.

28 March

Continued working at Palmyra Atoll. The REA teams occupied two established sites on the west and east sides of the atoll (PAL-16P and PAL-15P) and snorkeled at the longliner wreck, site PAL-6. The towed-diver survey team completed three tows around the western side of the island. Oceanography conducted fourteen 30-m CTD casts, during which two water quality profiles were performed collecting 16 water samples for later analysis of

chlorophyll (8 samples) and nutrient (8 samples) content. They also retrieved the inverted ADCP and the string of temperature recorders from in the channel. The *AHI* mapped portions of the western bank. Five 500-m CTD/water quality casts were conducted from the ship along an east/west transect to the west of the atoll at a 1.8-km interval, from which 60 water samples were taken for later analysis of chlorophyll (30 samples) and nutrient (30 samples) content. Departed for Kingman Reef.

29 March

Arrived at Kingman Reef at 0530 to begin field operations. The REA teams occupied established sites on the southern outer reef (KIN-11, KIN-17 and KIN-13). The towed-diver survey team completed five tows on the northeastern forereef and conducted one invertebrate collection dive. The oceanography team recovered and replaced one SST buoy, four STRs, and one recruitment plate array which was/is installed on the CREWS anchor that remains near the SST site. Additionally they installed a 2-MHz inverted ADCP in the La Paloma channel. The *AHI* mapped along the south inner and outer reef. At night the ship mapped the deeper banks around the reef.

30 March

Continued operations at Kingman Reef. The REA teams occupied established sites on the northeast outer and inner reef (KIN-4, KIN-10 and KIN-8). The towed-diver survey team completed five tows on the south forereef and backreef and one conducted one invertebrate collection dive. The oceanography team recovered and replaced one STR and installed a second STR in a new location. They also conducted twenty-one 30-m CTD casts during which 4 water quality profiles were performed collecting 32 water samples to be later analyzed for chlorophyll (16 samples) and nutrient (16 samples) content. They also conducted one invertebrate collection dive. The *AHI* mapped along the outside of the southern and western reefs. At night the ship mapped the deeper banks around the reef.

31 March

Continued operations at Kingman Reef. The REA teams occupied established sites on the southern backreef and lagoon interior (KIN-7, KIN-19 and KIN-12). The towed-diver survey team completed five tows on the northeast backreef and conducted one invertebrate collection dive. The oceanography team conducted thirty 30-m CTD casts during which 6 water quality profiles were performed collecting 48 water samples to be later analyzed for chlorophyll (24 samples) and nutrient (24 samples) content. The *AHI* mapped along the outside of the northeastern forereef and northwestern reef crest. At night the ship ran a 74-km ADCP box transect around the reef and conducted four 500-m CTD/water

quality casts during which 48 water samples were taken to be later analyzed for chlorophyll (24 samples) and nutrient (24 samples) content.

- 1 April Continued operations at Kingman Reef. The weather was calm at first but built during morning. At 1115 the ship recalled all the boats for the day. Before that time the REA teams occupied one established site on a patch reef in the lagoon (KIN-15). The towed-diver survey team completed three tows along the south backreef. The oceanography team conducted nine 30-m CTD casts during which two water quality profiles were performed collecting 16 water samples for later analysis of chlorophyll (8 samples) and nutrient (8 samples) content. The *AHI* mapped along the outside of the northwestern reef crest and western interior. After the boats were recovered the ship mapped the deeper banks around the reef.
- 2 April Continued operations at Kingman Reef. The REA teams occupied established sites in the southeast portion of the lagoon (KIN-3, KIN-5P and KIN-16P). The towed-diver survey team completed four tows along the southeastern backreef and in the lagoon pool. The team also conducted two invertebrate collection dives. The oceanography team installed one new STR and conducted thirteen 30-m CTD casts during which two water quality profiles were performed collecting 16 water samples for later analysis of chlorophyll (8 samples) and nutrient (8 samples) content. The *AHI* mapped along the northwestern backreef and completed several survey lines across the central lagoon. After the boats were recovered the ship mapped the deeper banks around the reef.
- 3 April Continued operations at Kingman Reef. The weather was marginal with winds in excess of 20 knots. The REA teams occupied existing station (KIN-21) and two new stations (KIN-22 and KIN-23); the latter two dives were qualitative species inventory dives. The towed-diver survey team conducted four invertebrate collection dives. The oceanography team recovered the ADCP deployed on 29 March and conducted two invertebrate collection dives. The *AHI* was not deployed because of concerns that the weather would deteriorate further making recovery dangerous. At 1630 the ship began transiting to Hawaii.
- 4 – 6 April Transit days. Cruise reported development, data analysis, and equator crossing ceremonies.
- 7 April Arrived at Penguin Bank at 1445 to begin ship-based mapping operations. Mapping continued through the night to define the 100-m isobath of the western portion of the bank.

8 April

Continued operations at Penguin Bank. At 1130 the ship began transiting to Honolulu. Arrived Honolulu. Disembarked Musburger, Wass, Ayotte, Maragos, Vargas Angel, Godwin, Tribollet, DeJoseph, Hall, Coccagna, Timmers, Dobbs, Hogrefe, Merritt, Young, Lino, Ferguson, Jones, Lundblad, Weiss, Charette, and Bostick

Table 1: Cruise statistics for Jarvis Island and the U.S. Line Islands.

	Jarvis Island	Palmyra Atoll	Kingman Reef
Towed-Diver Habitat/Fish Surveys	12	18	22
Combined tow lengths (km)	24.24	42.40	52.35
Fish Rapid Ecological Assessments	9	13	16
Benthic Rapid Ecological Assessments	9	13	16
Ocean Data Platforms (ODP) Recovered	1	-	-
Ocean Data Platforms (ODP) Deployed	1	-	-
SST buoys recovered	-	-	1
SST buoys deployed	1	1	1
STRs recovered	4	4	5
STRs deployed	8	9	7
CREWS buoys recovered	-	1	-
CREWS buoys deployed	-	1	-
Small vessel CTDs (33-m max)	45	63	73
Small vessel CTDs (200-m max)	12	6	5
Small vessel water quality profiles (30-m max) taken - 1 profile consists of chlorophyll and nutrient samples at 1 to 4 depths as depth allows.	18	12	14
Shipboard CTDs (500-m max)	10	12	7
Shipboard water quality profiles (1 profile consists of chlorophyll and nutrient samples at 6 depths.)	8	9	4
Nutrient Samples – total	123	102	80
Cholorophyll Samples – total	123	102	80
ADCP lines run, km	-	87	74
Multibeam mapping (sq. km)	316	1082	926
Scuba dives	120	175	217

MISSIONS AND RESULTS:

- A. Conduct ecosystem monitoring of the species composition, abundance, percent cover, size distribution, and general health of the fish, corals, other invertebrates, and algae of the shallow water (<35 m) coral reef ecosystems of Jarvis Island, Palmyra Atoll, and Kingman Reef.
 1. Continued the monitoring of coral reef habitats of Jarvis, Palmyra, and Kingman during this cruise. The process included the selection of long-term monitoring sites based on a rigorous coverage of the range of habitats present and their representative fish, coral, invertebrates and algae faunas, and the high probability of year-round access to the site. A list of sites was selected and refined during the course of the cruise. Both the fish and benthic survey teams participated in this monitoring effort occupying 52 stations. At each site a complete fish and benthic survey was conducted on the same 25-m transect lines. The fish surveys were conducted along three transect lines, while the benthic survey used two. The benthic survey covers three components of the reef habitat: coral, non-coral invertebrates, and algae. The methodology used to survey those sites is documented in Appendix A.3. Survey summaries and Descriptions of sites visited at Jarvis Island, Palmyra Atoll, and Kingman Reef are included within the Benthic Environment and Fish sections of Appendices B, C, and D, respectively.
 2. Towed-diver survey methods were used to provide a general description of reef habitat, invertebrates, and reef fishes over a large spatial scale. This method, described in Appendix A.4, allows monitoring large-scale disturbances and general distribution and abundance patterns of corals, macroinvertebrates, and reef fishes over 50 cm total length. The initial summaries of these data are integrated into the Benthic Environment and Fish sections.
- B. Conduct benthic habitat mapping of the reefs and submerged banks surrounding the Jarvis Island, Palmyra Atoll, and Kingman Reef using ship-based and launch-based multibeam echosounders and underwater towed cameras.
 1. Mapping from the *Hi'ialakai* and the survey launch R/V *AHI* resulted in the collection of high resolution multibeam bathymetry and backscatter imagery in each of the work areas. The survey methods used are described in Appendix A.1. The waters surrounding Jarvis Island were completely mapped in depths ranging from 4 to 3500 m. Preliminary maps are included in Appendix B.1. At Palmyra Atoll, all of the shelf and slopes ranging from 20 to 3500 m were surveyed. Preliminary maps are included in Appendix C.1. In addition, the western and central lagoon waters deeper than 3 m were surveyed. The eastern lagoon was not accessible and therefore not surveyed. Outside the atoll some areas of the western and eastern banks less than 20 m deep but accessible to the survey launch were not surveyed. At

Kingman Reef all of the seabed slopes from 20 m to 3500 m were surveyed. Preliminary maps are included in Appendix D.1. Approximately 20% of the western reef crest and interior reef was also surveyed but large areas remain to be surveyed.

2. Towed-diver survey methods were used to record video data that will provide data to ground-truth the high-resolution bathymetry and imagery data collected in depths less than 30 m.
- C. Deploy an array of CREWS buoys, SST buoys, subsurface Ocean Data Platforms, subsurface wave and tide recorders, and subsurface temperature recorders to allow remote long-term monitoring of oceanographic and environmental conditions affecting coral reef ecosystems of Jarvis Island, Palmyra Atoll, and Kingman Reef.
1. A total of one CREWS Buoy, four Sea Surface Temperature (SST) buoys, one Ocean Data Platform (ODP), 24 Subsurface Temperature Recorders (STR), and one Recruitment Plate Array were deployed during the cruise. In addition to these standard instrument deployments, one Nortec Aquadop ADCP was tested during temporary deployments in the channel at Palmyra Atoll and in the reef pass at the southeast corner of Kingman Atoll and one vertical string of three STRs was also deployed near the ADCP in the Palmyra channel to augment its temperature data. Refer to See Appendix A.2 for a description of methodologies and to Appendices B.2, C.2, and D.2 for summaries of the work conducted at each site. Unless otherwise noted in the itinerary and the appendices, most deployments were replacements of existing instrumentation to assure the continuity of data for the assessment of oceanographic conditions.
 2. In addition to these standard deployments an investigation was undertaken using an inverted ADCP to provide an initial understanding of the water volume that is transported in and out of the dredged channel at Palmyra Atoll and La Paloma Channel at Kingman Reef.
- D. Collect water samples for analysis of nutrient and chlorophyll levels.
1. Water quality profiles were conducted as a subset of these casts at 44 sites resulting in the collection of 179 nutrient and 179 chlorophyll samples.
- E. Conduct shipboard CTDs to a depth of 500 m, shallow water CTDs from small boats to a depth of ~30 m, and shipboard ADCP surveys around reef ecosystems to examine physical and biological linkages supporting and maintaining these island and atoll ecosystems.
1. Throughout the cruise, “small vessel” conductivity, temperature and depth (CTD) casts to a maximum depth of 33 meters, including turbidity

measurements, were performed at 181 sites out of a 6-m SAFE boat. Small vessel CTD casts were made to a maximum depth of 200 meters at 23 sites throughout the cruise with 8 of these casts focused on the effort to study the upwelling at Jarvis Island (ref. below).

2. Shipboard CTD casts/water quality profiles, including dissolved oxygen and chlorophyll concentration measurements, were performed along ADCP transects around Palmyra and Kingman Atolls for a total of two ADCP transects, 19 CTD casts and 13 water quality profiles with a total of 78 chlorophyll and 78 nutrient samples being collected. Additional shipboard CTD casts were performed from the vessel to provide sound velocity profiles to support the mapping effort. These casts will also be analyzed as part of the oceanographic data set.
 3. At Jarvis Island, a series of CTD casts were conducted to 1) elucidate the nature of the high frequency (semidiurnal) temperature variability caused by the Equatorial undercurrent impinging on the western side of the island, 2) characterize the nutrient input from this cold-water upwelling into the surface mixed layer, and 3) measure the nearshore nutrient and chlorophyll gradient around the island. This work included a 26-hour high-resolution CTD time-series conducted 2 kilometers off the western side of the island.
- F. Determine the existence of threats to the health of these coral reef resources from anthropogenic sources, including marine debris.
1. During this cruise, initiated the monitoring of coral and coralline algal diseases in reef habitats of Jarvis, Palmyra, and Kingman. Surveys were conducted in conjunction with the continued long-term monitoring of fish, coral, invertebrates, and algae. The coral disease team participated in this effort occupying 9 sites at Jarvis Island, 13 at Palmyra Atoll, and 16 at Kingman Reef. At each site, quantitative surveys were conducted along the first two transect lines deployed by the fish team. The methodology used is documented in Appendix A.3. Survey summaries and Descriptions of sites visited are included within the Benthic Environment sections of Appendices B, C, and D, respectively.
- G. Collect ADCP data during all transits. The ADCP unit shall be configured to collect narrow-band data in 16 meter bins (deepwater mode).
1. ADCP data were collected during all transits, totaling 4430 km of ADCP deepwater transect data.

**SCIENTIFIC
PERSONNEL:**

Scott Ferguson, Chief Scientist, Mapping Team, Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service (NMFS), Coral Reef Ecosystems Division (CRED)

Craig Musburger, Fish Team, University of Hawaii (UH), Joint Institute for Marine and Atmospheric Research (JIMAR), PIFSC-CRED

Paula Ayotte, Fish Team, UH-Hilo

Todd Wass, Fish Team, UH-JIMAR, PIFSC-CRED

Bernardo Vargas Angel, PhD, Benthic Team – Coral disease, UH-JIMAR, PIFSC-CRED

James Maragos, PhD, Benthic Team – Corals, U.S. Fish and Wildlife Service

Scott Godwin, Benthic Team – Invertebrates, UH-Hawaii Institute of Marine Bioblogy, Bishop Museum

Aline Tribollet, PhD, Benthic Team – Algae, UH-JIMAR, PIFSC-CRED

Bonnie DeJoseph, Benthic Team – Algae, UH-JIMAR, PIFSC-CRED

Amy Hall, Towed Diver Survey Team – Fish, UH-JIMAR, PIFSC-CRED

Molly Timmers, Towed Diver Survey Team – Habitat, UH-JIMAR, PIFSC-CRED

Edmund Coccagna, Towed Diver Survey Team – Fish, UH-JIMAR, PIFSC-CRED

Eric Dobbs, Towed Diver Survey Team – Habitat, UH-JIMAR, PIFSC-CRED

Kyle Hogrefe, Oceanography Team, UH-JIMAR, PIFSC-CRED

Daniel Merritt, Oceanography Team, UH-JIMAR, PIFSC-CRED

Charles Young, Oceanography Team, UH-JIMAR, PIFSC-CRED

Kevin Lino, Oceanography Team, UH-JIMAR, PIFSC-CRED

Emily Lundblad, Mapping Team, UH-JIMAR, PIFSC-CRED

Jeremey Jones, Mapping Team, UH-JIMAR, PIFSC-CRED

Jonathan Weiss, Mapping Team, UH-JIMAR, PIFSC-CRED

Stephane Charette, Dive Master, UH-JIMAR, PIFSC-CRED

Jim Bostick, Chamber Operator, National Oceanic and Atmospheric Administration Dive Center

DATA COLLECTED:

- Quantitative surveys of reef fishes (larger than 25 cm TL) to species level from REA team Stationary Point Counts
- Quantitative surveys of all reef fishes to species level from REA team Belt Transects
- Reef fish species presence records from REA team roving diver surveys
- Digital images of diseased coral
- Quantitative data surveys for coral size class distribution, abundance, and diversity
- Quantitative data surveys for benthic cover, including live coral, dead coral, pavement, sand, macroalgae, crustose coralline algae, and other sessile invertebrates
- Field notes on signs of coral bleaching or disease
- Samples of diseased coral for histopathological analysis
- Digital images from algal photoquadrats
- Algal voucher specimens
- Algal field notes of species diversity and relative abundance
- Acoustic Doppler current profile (ADCP) data
- Conductivity, temperature and depth data including turbidity from small vessel casts
- Conductivity, temperature and depth data including dissolved oxygen and chlorophyll concentration from on shipboard casts
- Water samples for nutrient analysis – frozen water stored for post-cruise processing.
- Water samples for chlorophyll analysis – filtered with frozen filter stored for post-cruise processing
- Oceanographic data downloaded from previously deployed instrumentation
- Digital images of the benthic habitat from towboard surveys
- Macroinvertebrate counts from towboard surveys
- Quantitative surveys of reef fishes (larger than 50 cm TL) to species level from towboards
- Habitat lineation from towboard surveys
- Benthic composition estimations from towboard surveys

(/s/Scott Ferguson)

Submitted by: _____
Scott Ferguson
Chief Scientist

(/s/David Kennedy)

Approved by: _____
David Kennedy
Program Manager
Coral Reef Conservation Program

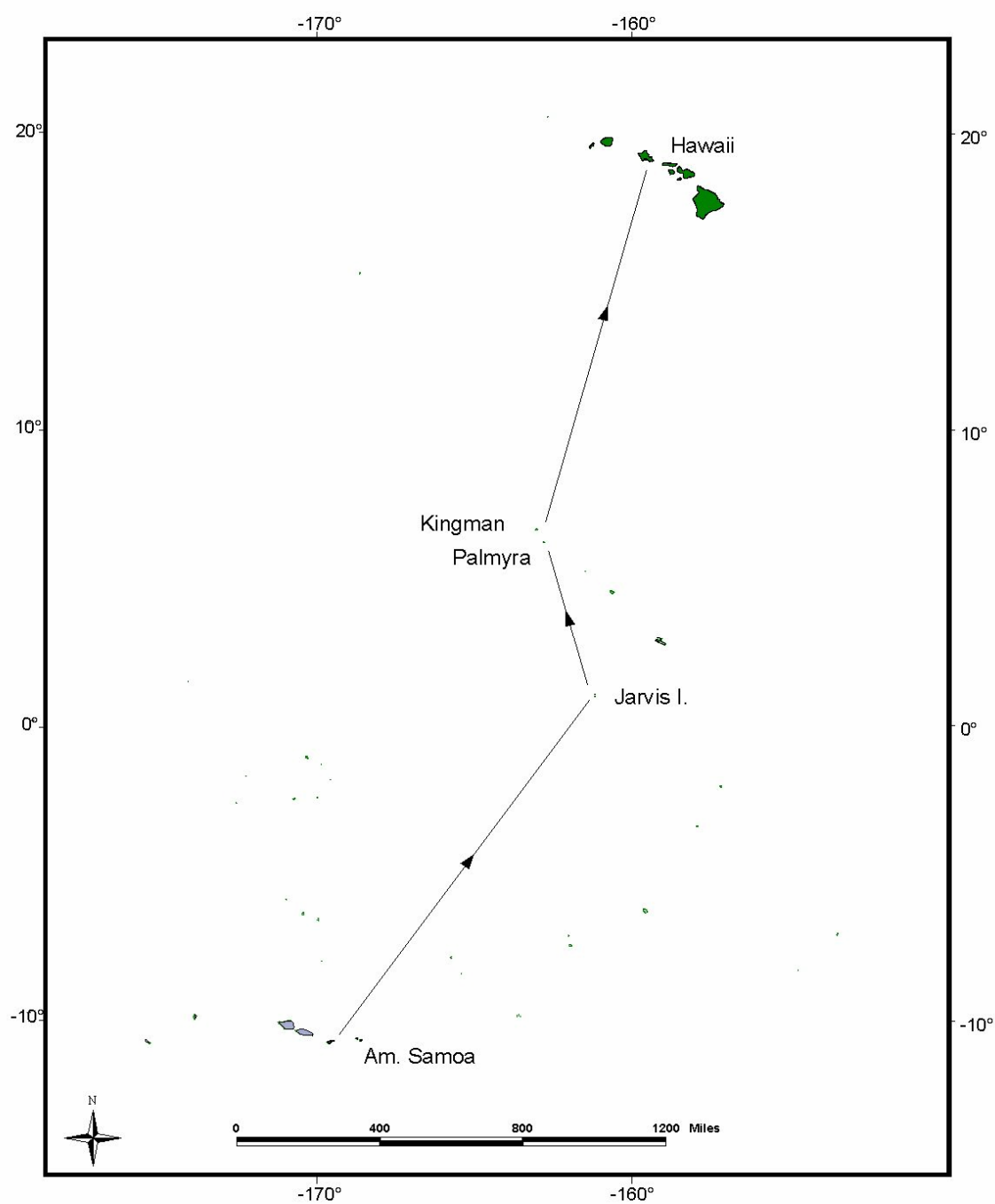


Figure 1. Track of the *Hi'ialakai* HI-06-04, March 15 – April 8, 2006.